Arid Zone Journal of Engineering, Technology and Environment, December, 2018; Vol. 14(4): 740-747

Print ISSN: 1596-2490, Electronic ISSN: 2545-5818, www.azojete.com.ng

A REVIEW ON ENERGY AND LOCATION AWARE ROUTING PROTOCOLS IN MANE

E. E. Agbon[1*] and A. D. Usman[2]

[1,2]*Department of Electrical and Computer Engineering, Faculty of Engineering, Ahmadu Bello University, Zaria, Kaduna State, Nigeria*

Corresponding auther's Email address : eagbonehime1@gmail.com, aliyuusman1@gmail.com

Abstract

Mobile Ad-hoc networks (MANETs) are a group of mobile nodes that are wireless and self-organized. They create a network that is temporal and without the aid of any centralized access point. MANETs suffer from a reduced network lifetime, low throughput, increased power consumption and the possibility of an intermediate node to become a bottleneck in the network due to inefficient routing protocols. Many researchers have attempted to mitigate some of the above mentioned challenges by using topology based routing protocols, energy based routing protocol or location aware routing protocols, yet there is still problem of low throughput, end-to-end delay, node energy depletion and low network lifetime. This paper presents a review of energy and location aware routing protocols in mobile ad-hoc networks and proposes better ways to mitigate these problems with the aim of achieving an improved energy aware routing in MANET.

Keywords - Location Aided Routing, MANET, AODV, Energy Aware, Route discovery.

1. Introduction

The major classification of wireless networks is into two types, one with a specified infrastructure and the other is without specification in terms of infrastructure (Muhammad *et al.,* 2016). Routing in ad hoc wireless network is complex due to the absence of any central coordinator. This informs the distributed manner of routing whereby all nodes coordinate themselves to enable communication in the network (Muhammad *et al.,* 2016). Figure 1is a diagram of an infrastructure and infrastructure less networks. MANET is made up of nodes that are self-configuring, where each node in the network move about freely and are connected to each other via wireless links. These nodes have the ability to randomly organize themselves and are interconnected and harmonized in terms of time to form a dynamic (active/motion) topology (Patil and Gaikwad, 2015) . In order to maximize the lifetime of nodes, one must ensure that traffic routing is done in such a way that energy consumption is highly minimized as energy efficient routing improves the battery life and routing capability of nodes (Patil and Gaikwad, 2015).

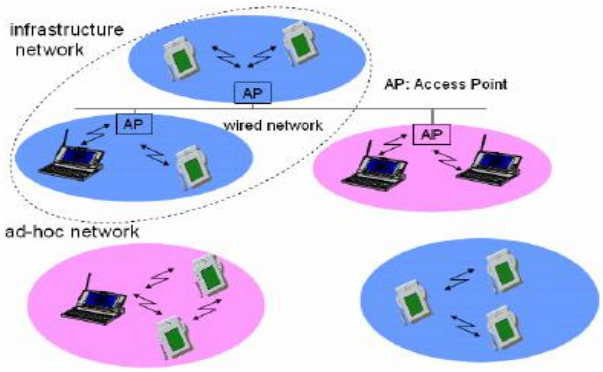

Figure 1: Infrastructure and Infrastructure less Networks (Muhammad *et al.,* 2016).

During the active state of the network, node energy is consumed during the reception, transmission and processing of data (Ahmad *et al.,* 2015). Exhausting the energy of any node in MANET negatively affects the network efficiency, communication performance and network lifetime as

MANET is peer to peer network (Singh *et al.,*2014). In order to improve the network life time and communication performance, packets must communicate taking into consideration the state and energy of individual node. Thus, routing is one of the best ways to manage the energy in MANETs (Sun, 2000).

The aim of MANET routing is aimed at establishing accurate, efficient and effective path but also need to consider the energy efficiency which is the most challenging task due to its characteristics (Choubey *et al.,* 2012). An energy efficient and location aware routing is a routing protocol that takes into consideration the energy consumed during routing and also reduces the area where control packets are transmitted towards the desired destination with the aim of reducing congestion that may result due to flooding. In an attempt to solve the problem of energy management, many researchers have adopted a variety of routing protocols. These protocols are majorly sub divided into three categories (Singh *et al.,*2014) :

1. Efficient routing path in terms of energy.
2. Reliable routing path in the network.
3. Highest energy node routing path.

The main focus of paths that are efficient in terms of energy is to ensure that the cost of energy during communication is reduced to the barest minimum so as to mitigate the energy consumption of all nodes present in the network (Sun, 2000). The mitigation of energy consumed by node is achieved by either reducing the active energy (during packet transmission) or the inactive energy waste (idle state) of mobile nodes (Sun, 2000). The focus of reliable routing path protocol is to ensure that paths that are chosen for sending packet have few probability of retransmission when recovering from link failure in order to avoid dropping of packets. Routing path with higher energy nodes protocols is concerned with chosen paths with high node energy (Singh *et al.,*2014) . Furthermore, the network connectivity strength is also a factor of node transmission range (Koutsonikolas *et al.,* 2005). Node connectivity is directly proportional to node transmission range especially at high speed of nodes. Node mobility usually leads to link failure in multiple hop communication due to the dynamic nature of MANET (Kaliya *et al.,* 2012). Additionally, an increase in the transmission range of power also increases the one hop distance of the nodes in the network, which will reduce the possibility of link failure due to node mobility (Karp, B., and Kung, 2000). Location aware routing protocols that are position based ensure efficient transmission of data in ad-hoc networks (Karadge and Sankpal, 2013). Examples of such protocols include; Location Aided Routing (LAR), Distance Routing Effect Algorithm for Mobility (DREAM), Greedy Perimeter Stateless Routing (GPSR) etc. Location-Aided Routing (LAR) protocol is a type of protocol that makes use of location information of nodes gotten from GPS system or any other location device to identify the request zone and expected zone before the commencement of data packet forwarding (Karadge and Sankpal, 2013). DREAM is a type of routing protocol that has the ability to maintain the location information of each node in the network inside a routing table which is now used in the transmission data packet. This protocol ensures that each node at a particular period of time broadcasts a control packet containing its own co-ordinates (Carvalho *et al.,* 2012). GPSR takes into consideration the distance of nodes with respect to their location in forwarding data packets. In this protocol, packets forwarding is done in a greedy manner by considering a node that is closer to the desired destination (Egbugha, *et al.,* 2017). This process is a continues one, until the desired destination is reached. In some cases during data packet transmission, the preferred path of forwarding a packet may be through a node which is farther in distance from the destination node. In such situation, GPSR adopts the right hand rule in forwarding packet around a barrier and the greedy forwarding immediately resumes (Gopinath *et al.,* 2012).

2. Categories of Routing Protocols

MANET routing protocols are majorly categorized into two with respect to their existing architectural framework.

A. Routing Protocols based on Network Topology

i. Reactive Routing Protocol

Reactive routing protocol is an on-demand protocol where the reactive source set-ups the routing process in the network. In this protocol, route is only established when the source desires to communicate with a desired destination. Setting up of route begins by a route request packet from the source node followed by a corresponding route reply packet from the destination node (Artail *et al.,* 2012). There are varieties of reactive routing protocols which includes Dynamic Source Routing (DSR), Ad hoc On-demand Distance Vector (AODV) etc. (Sujane *et al.,* 2015). Usually, AODV protocol makes use of Route request (RREQ) packets in discovering route from source to destination by packet flooding in the whole network. When an intermediate node gets RREQ packets, it responds to it by sending a Route reply packet (RREP) only if it has maximum sequence number route to the destination (Kush *et al.,* 2012). The sequence number gives an idea of the route freshness. During communication process the destination node uni-casts a RREP packet towards the source node via intermediate nodes. These intermediate nodes set up route in their routing tables (Sujane *et al.,* 2015). AODV uses a route maintenance process for link layer notification**.**

ii. Proactive Routing Protocol

Proactive routing protocol is designed to initiate the route ahead of time, and has the ability to maintain information about routing at every point of time regarding connectivity of every node to all other mobile nodes that are present in a network due to periodic update (Kush *et al.,* 2012). Proactive routing protocols helps node to have general idea of the network topology. Thus, all nodes are able to make a quick decision about routing (Majdkhyavi and Hassanpour, 2015). However, periodic messages or control packets make an extra overhead. Examples of proactive routing protocols are Destination Sequence Distance Vector (DSDV) and Optimized Link State Routing (OLSR) (Muhammad *et al.,* 2016). DSDV routing protocol is a type of protocol that maintains the table at every node at any point of time as it is table driven. DSDV updates table entries by the use of update mechanism (Ko and Vaidya, 2000). Proactive routing protocol comes with some additional information about the nodes i.e. their geographical location with the help of location system like GPS to locate mobile nodes and to preserve node positions (Mamoun, 2011). Position based routing protocol does not maintain route information in a table neither does it require any information update by node in a routing table (Lalitha and Rajesh, 2013). Here, route search is done with the help of location service and some kind of forwarding mechanism. The most important benefit of position based routing protocol is that one can transmit packets to a particular location within a restricted area (Geo-casting). LAR and Distance Routing Effect Algorithm for Mobility (DREAM) are the example of position based routing protocol (Sujane *et al.,* 2015).

iii. Hybrid Protocols

Hybrid routing protocols is a type of protocol that combines the qualities of both reactive and proactive routing protocols in an attempt to mitigate the shortcomings of both proactive and reactive routing protocols. Generally, this protocol makes use of hierarchical network architectures (Dommety and Jain, 1999). Some hybrid routing protocols for MANET are Zone Routing Protocol (ZRP), Zone-based Hierarchical Link State routing (ZHLS).

B. Location-aware routing protocol

A location-aware routing protocol is a type of protocol that assumes that each node in the network is aware of each other's location (Dommety and Jain, 1999). Example of location aware routing protocol includes; Location Aided Routing (LAR), Greedy Perimeter Stateless Routing (GPSR), and A Distance Routing Effect Algorithm for Mobility (DREAM) (Dommety and Jain, 1999).
Section three is the review of resent works on MANET and it also identifies the gaps in the research area.

3. A Review of Energy and Location Aware Routing Protocols

Bindra *et al.,* (2013) developed a scheme that evaluated all the effects of TTL increment and threshold value which was adopted in the work to analyze route discovery process in AODV routing protocol to mitigate communication overheads. With respect to diameter and size of the network, different values of TTL parameters were arbitrarily chosen in the work. To further analyze the effects of TTL parameters, TTL threshold and TTL increment on route discovery process, simulation was carried using OPNET simulator. The result of the work showed that performance of route discovery, link failure and repair depends on optimal value of TTL increment and threshold. However in their work, a lot of node energy will be expended as constant route update is required for node location during route search thereby reducing network lifetime. Also, the work did not take into account the challenges encountered during data packet forwarding such as; the possibility of a node becoming a bottleneck as this will reduce the systems throughput.
Dommety and Jain, (1999) proposed a system that extensively performs energy conservation through hexagonal Geographic Adaptive Fidelity (GAF) grid structures with the help of LAR scheme. The scheme made use node location through GPS technique to improve the performance matrices such as energy saving, routing overhead, and network life time. GAF protocol was used as it tended to extend the lifetime of self- configuring system while preserving connectivity (Patel and Joshi 2009). When the redundant nodes were identified, GAF switch off their radios to conserve the energy (Rinhayat *et al.,* 2013). Although they had an improvement on energy saving, routing overhead, and network life time, but there work will lead to an increase is overhead in the request regions of the grids when all the nodes in the defined area undergoing transmission with other nodes in the large network area and this may lead to having bottleneck nodes due to internal overhead and consequently reduce the network lifetime and consume more energy during the attempt of packet retransmission.
Gopinath *et al.,* (2012) designed an On-Demand Based Energy Efficient Routing Protocol (ODBEERP). The proposed protocol was aimed at discovering minimum power-limitation route. The work was able to propose a more accurate analysis to track the energy computation and improved the network performance during path discovery and in mobility conditions. The result of the work showed that the ODBEERP achieves better throughput, a reduced delay, high packet delivery ratio and good energy efficiency than the standard AODV routing protocol. However, they adopted the standard method of AODV route search and this will result to constant update of node routing table and hence more energy is consumed by the route search protocol during route search process. Therefore, there work will experience overhead that will consequently promote more bottleneck nodes in the network and thus reduce network throughput and lifetime.
Gupta and Gupta, (2011) performance a comparison of energy efficient AODV protocols in MANET. The work was able to optimize the control messages handling process of AODV routing protocol to conserve the energy of nodes. To achieve this, a threshold level of energy was adopted which strictly determines if a node should participate in routing process or not. This decision makes available the possibility of such a node to suffer bottleneck as node would want to process many packet based on its energy alone and this will lead to rapid draining of energy, delay of packet transmission and

subsequently, energy consumption. The work also experience large route search delay due to frequent update of routing table during route search and this may lead to a reduced network lifetime.
Koutsonikolas *et al.,* (2005) performed a study on the behavior and performance of the three frequently used MANET routing protocols with respect to different transmission power of individual nodes of the network was performed. Destination Sequence Distance Vector (DSDV) routing protocol, AODV routing protocol and Dynamic Source Routing (DSR) protocol was selected for the study. The positive and negative impact of increase in transmission power of individual nodes was analyzed. However, this work only considered power parameters like reception and processing power which has direct effect on MANET performance.
Kumar *et al.,* (2010) proposed an energy aware reactive routing protocol by the introduction of criteria based on energy and distance based threshold. In the work, routing scheme (established using GRA) with better power feature using geographical information of the nodes was proposed. It was assumed that each node will get its geographical position from GPS as each routing table consists of all neighboring node. The work was able to reduce energy consumption during data transmission. The short coming of this work is that, delay may increase as the system requires more calculations initially for setting route. Also, node was selected based on energy level and distance which indicates the possibility of collision of packets and rapid discharge of node battery as node has no restriction to the number of packets it can process base on its buffer size. And hence, a node with a very low energy and being close to the destination may attempt to process packets from transmitting sources and this may lead to packet drop as the node has low energy. This short coming will lead to more retransmissions due to initial dropped packets, and hence an increase in route overhead and energy consumption. This will reduce the network lifetime and lower the throughput due to high latency.

Liu *et al.,* (2006) developed an Improved Location aided Cluster based Routing Protocol (ILCRP) for GPS enabled MANETs. The work looked into metrics such as end-to-end delay, control overhead and packet delivery ratio. The results of the proposed scheme shows better performance than GPS free or GPS Scarce MANETs as the proposed scheme provides a stable cluster containing members that remain within their associated clusters for an extended period of time, despite the targeted system having node speeds exceeding normal MANET scenarios. However, this work did not consider the residual energy of the cluster head. Because at lower energy, the time of processing a packet will be increased hence affecting the transmission time of packets which will lead to delay and consequently extra node energy consumption in an attempt to search for new route. There work made use of the standard AODV ring route search process, and this will lead to congestion and hence increase possibility of having bottleneck nodes.

Mangai and Tamilarasi, (2011) proposed a system which is a type of hybrid MANET protocol that makes use of functionality of both topology based routing and position based routing protocols. The paper proposed a new design for 802.11 MANET protocol which is a hybrid of features from AODV and LAR protocols for mobile nodes which helps against the possibility of collision and reducing end-to-end delay for a single source.. The proposed system suggest that only a single source is allowed to communicate with an intermediary node at a giving time not minding the fact that the current intermediary node has the capacity to process packets from multiple source with respect to its energy and buffer size. Hence the proposed system introduces source delay, reduced throughput and power consumption as other sources who attempt to transmit via a common intermediary node most have to wait till when the network is sensed to be free.

Qabajeh *et al.,* (2009) developed a modified local route repair method from the existing one developed. The work improved the existing local route repair method in AODV to ensure an efficient quality of broadcast of packets and minimize flooding process. To achieve this, the

developed scheme initially creates the group of mobile nodes and then broadcast packets. If the link breaks or fails, the requestor (intermediate node that only forwards request in both sides) node broadcast RREQ packet after increasing the destination sequence number and waits for RREP. However, the work did not consider altering the TTL value of the RREQ packet in other to provide efficient number of routes as this will minimize the scope of link failure. Also, the possibility of a node becoming a bottleneck was not considered as this may result in link failure and hence reduce the network throughput.

(Singh *et al.,*2014) proposed a framework to provide Quality of Service (QoS) with the help of location aware environment called Location Based Power Aware Routing (LBPAR). The work, unlike the LAR takes into consideration parameters like bandwidth requirement and battery life of all the intermediate nodes on a path to destination. The proposed (LBPAR) protocol used location information to minimize the Request Zone to reach the destination node. LBPAR used the concept of slope of line, which was used to minimize the search area and also the number of calculations which in turn increases the battery life and route life. However, this approach will lead to another overhead within the route request zone as the number of allowable hop count or TTL was not defined. This process will lead to continues broadcast of RREQ packet from one hop to another within the route request zone in an attempt to reach the destination. Lack of a threshold value for TTL will lead to possible overhead which will in turn support the generation of bottleneck nodes due to increase in congestion. Hence, this will reduce the network throughput and node lifetime as retransmission of packets needs to be initiated and thus, node energy depletion.

4. Conclusion

The paper discusses the classes of different ad-hoc routing protocols and reviewed some energy and locations based routing protocols. The difference between the Location based routing protocols is in the manner of searching and sustaining routes to their destination (Aggarwal *et al.,* 2014). The energy aware routing protocols consider routes with high energy nodes or nodes with low transmission power. For better performance of MANET in terms of high throughput, high packet delivery ratio, low energy consumption and reduced route search overhead, the following recommendations are made. These recommendations are aimed at addressing the gaps identified in the review (in section 3):

i. The development of new routing protocol should focus on improving the existing hybrid routing protocols in MANET in terms of optimizing the sleep or idle mode of nodes.
ii. Optimization algorithms such as the metaheuristic e.g. Artificial Fish Swamp Algorithm (AFSA) and the heuristic algorithms e.g. Fuzzy logic can be tested in modeling the route search process in MANET.
iii. Develop a protocol that will consider the energy and bandwidth of nodes, as well as setting node distance threshold value in route search and packet forwarding.
iv. Location Based Power Aware Routing (LBPAR) technique [29] can be modified by taking into consideration the transmission power of sending nodes. Intelligent routing schemes can be developed that will optimally select the transmission power of source nodes.

References

Aggarwal, A., Gandhi, S., Chaubey, N., Tada, N., and Trivedi, S. 2014. NDTAODV: Neighbor Defense Technique for Ad Hoc On-Demand Distance Vector (AODV) to mitigate flood attack in MANETS. *arXiv preprint arXiv:1405.6216*.

Ahmad, SJ., Reddy, VSK., Damodaram, A., and Krishna, PR. 2015. "Delay optimization using Knapsack algorithm for multimedia traffic over MANETs," *Expert Systems with Applications*, pp. 6819-6827.

Artail, H., Safa, H., Mershad, K., Abou-Atme, Z. and Sulieman, NC. 2008. "A cooperative and adaptive caching system for MANETs," *IEEE Transactions on Mobile Computing*, pp. 961-977.

Basagni, S., Chlamtac, I., Syrotiuk, VR. and Woodward, BA. 1998. "A distance routing effect algorithm for mobility (DREAM)," In *Proceedings of the 4th annual ACM/IEEE international conference on Mobile computing and networking*, vol. 2, no. 3, pp. 76-84.

Bindra, P., Kaur, J. and Singh, G. 2013. "Effect of TTL parameter variation on performance of AODV route discovery process," *International Journal of Computer Applications*, vol. 70, no 4, pp. 0975-8887.

Carvalho, MM., Margi, CB., Obraczka, K. and Garcia-Luna-Aceves, JJ. 2004. "Modeling energy consumption in single-hop IEEE 802.11 ad hoc networks," *In Computer Communications and Networks, 2004. ICCCN 2004. Proceedings. 13th International* Conference, pp. 367-372.

Choubey, SD., Jain, V., and Thakur, RS. 2012. "Performance investigation of 802.11 MAC DCF," *International Journal of Distributed and Parallel Systems*, vol 3, pp. 166.

Egbugha, MC, Umoh, IJ, Tekanyi, AMS. 2017. "Development of an improved intrusion detection based secured robust header compression technique," *International Journal of Computer Application,* pp. 22-39.

Dommety, G. and Jain, R. 1999. "Potential Networking Applications of Global Positioning System (GPS)," Computer Science Department, The Ohio State University, *Technical Report TR-24*.

Gopinath, S., Sureshkumar, N., Vijayalakshmi, G., Natraj, NA., Senthil, T. and Prabu, P. 2012. " Energy efficient routing protocol for MANET," *International Journal of Computer Science Issues(IJCSI)*, vol. 9.

Gupta, N. and Gupta, R. 2011. "Estimated New Routing Scheme in MANETs" *International Journal of Computer Applications (IJCA)*, pp. 15-19.

Karp, B. and Kung, HT. 2000. "Greedy perimeter stateless routing for wireless networks," In *Proceedings of the 6th annual international conference on Mobile computing and networking*, vol. 3, no. 5, pp. 243-254.

Karadge, P., and Sankpal, DS. 2013. "A performance comparison of energy efficient AODV protocols in mobile ad hoc networks," *International Journal of Advanced Research in Computer and Communication Engineering,* pp. 2278-1021.

Kaliyar, P., Pandey, K. and Singla, G. 2012."A Reliable and Energy Efficient Routing Protocol for MANETs," In *the fourth International Workshop on wireless & Mobile Networks (WiMo-2012)*, pp. 225-235.

Ko, YB. and Vaidya, NH. 2000. "Location-aided routing (LAR) in mobile ad hoc networks," *Wireless networks,* vol. 6, no. 5, pp. 307-321.

Koutsonikolas, D., Das, S. M., Pucha, H., and Hu, YC. 2005. "On optimal TTL sequence-based route discovery in MANETs," In *Distributed Computing Systems Workshops, 25th IEEE International Conference,* pp. 923-929.

Kumar, R., Misra, M., and Sarje, AK. 2010. "A simplified analytical model for end-to-end delay analysis in MANET," *IJCA Special Issue on "Mobile Ad-hoc Networks" MANETs*, pp. 195-199.

Kush, A., Taneja, S. and Sharma, D. 2010. "Energy efficient Routing for MANET," In *Methods and Models in Computer Science (ICM2CS), International Conference on* IEEE, pp. 112-116.

Lalitha, V. and Rajesh, R. 2013. "The Impact of Transmission Power on the Performance of MANET Routing Protocols," *IOSR Journal of Engineering (IOSRJEN),* vol. 3, no. 2, pp. 34-41.

Liu, RP., Rogers, G. and Zhou, S. 2006. "WSN14-3: Honeycomb architecture for energy conservation in wireless sensor networks," In *Global Telecommunications Conference GLOBECOM'06,* pp. 1-5.

Majdkhyavi, N. and Hassanpour, R. 2015. "A Survey of Existing Mechanisms in Energy-Aware Routing In MANETs," *International Journal of Computer Applications Technology and Research,* pp. 673-679.

Mamoun, MH. 2011. "Location aided hybrid routing algorithm for MANET," *International Journal of Engineering & Technology IJET-IJENS*.

Mangai, SV. and Tamilarasi, A. 2011. "A new approach to geographic routing for location aided cluster based MANETs," *EURASIP journal on wireless communications and networking*, pp. 18.

Mohammad, AAK., Mirza, A. and Vemuru, S. 2016. "Energy Aware Routing For Manets Based On Current Processing State Of Nodes," *Journal of Theoretical and Applied Information Technology,* vol. 91, pp. 340.

Patel, A. and Joshi, R. 2009. " Energy conservation for wireless mobile ad hoc networks using hexagonal gaf protocol," In *Proceedings of the 12th International Conference on networking, VLSI and signal processing*. pp. 29-34.

Patil, DS., and Gaikwad, R. 2015. " *PowerMac:* A new protocol design for location based Ad-hoc networks," Paper presented at the Industrial Instrumentation and Control (ICIC), pp. 405-408.

Paulus, R., Garg, R., Kaur, T. and Rajput, SVS. 2013. Analyzing the effect of varying CBR on AODV DSR IERP Routing Protocols in MANET. *IOSR Journal of Computer Enginneing (IOSR-JCE)*, vol. 14, pp. 76-80

Qabajeh, LK., Kiah, MM., and Qabajeh, M. 2009. "A qualitative comparison of position-based routing protocols for ad-hoc networks," *International Journal of Computer Science and Network*, pp. 131-140.

Rinhayat, HK., Jain, A. and Chandravanshi, K. 2014. "Prolong the Life time of Network using Minimum Energy Consumption in MANET," pp.5-6.

Singh, VK., Kushwaha, DS., Sujane, R. and Taram, M. 2014. Congestion Control in Multi-Flow Environment Using Multipath Routing Base in MANET. *International journal of Inovative Research in Computer and Communication Engineering,* pp. 8620-8627.

Sujane Raju, Singh, Vikash Kumar, Devendra Singh Kushwaha, and Manish Taram., 2015. "TTL Variance Prophecy based Enhancement of AODV Routing Protocol in MANET," *International journal of Inovative Research in Computer and Communication Engineering,* vol. 91, pp. 8637-8642.

Sun, AC. 2000. "Design and Implementation of Fisheye Routing Protocol for mobile ad hoc Networks" (Doctoral dissertation, Massachusetts Institute of Technology), pp. 7-9.